

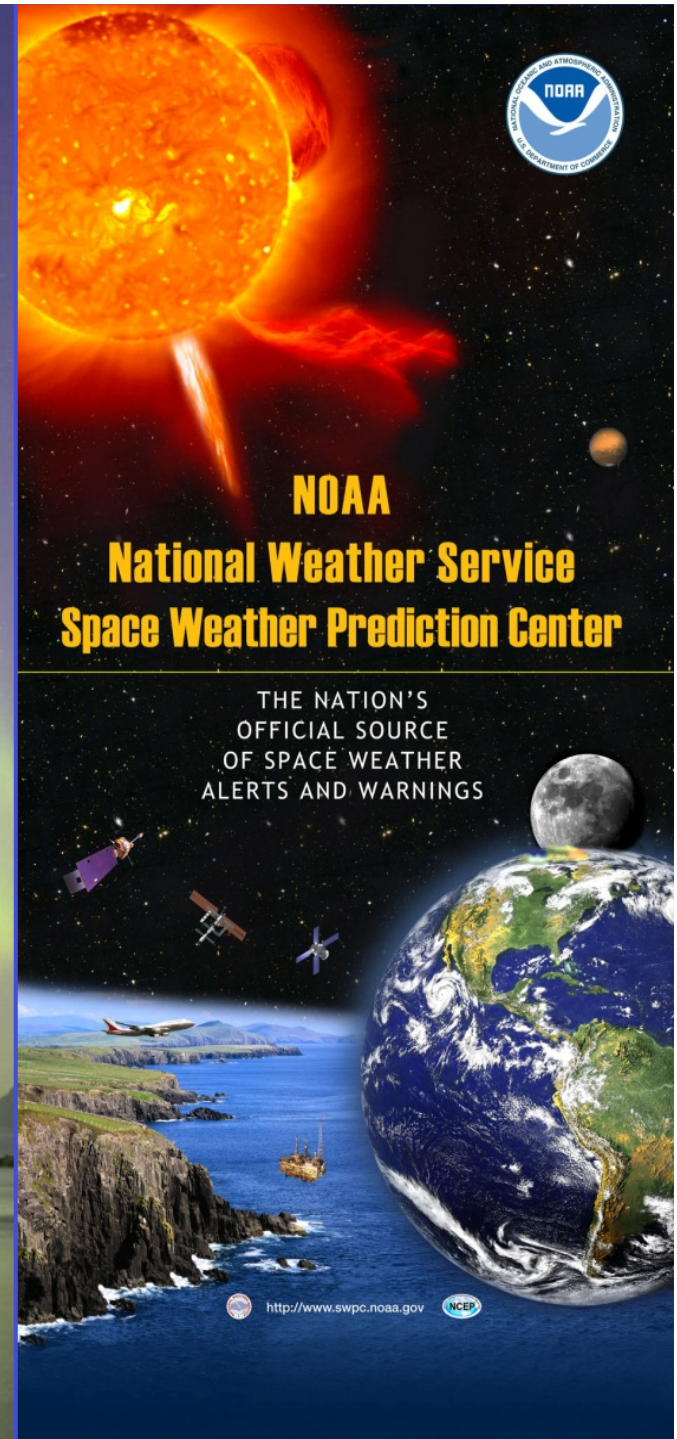
# Preparing the U.S. to Respond to Space Weather Events

**Dr. Genene Fisher**

**Senior Advisor for Space Weather**

**NOAA National Weather Service**

TIEMS Oslo Space Weather Conference  
24 October 2012

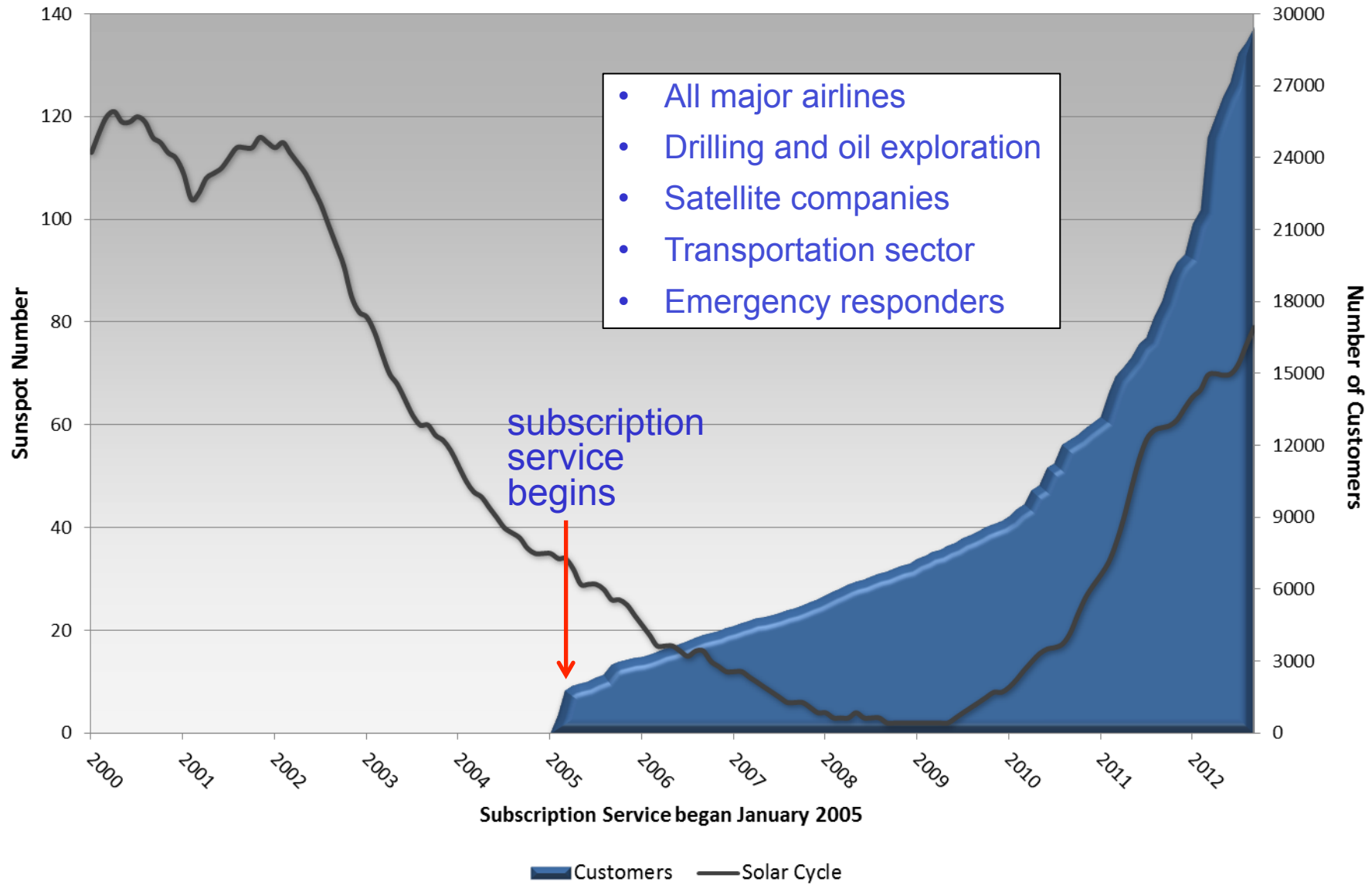


# Outline

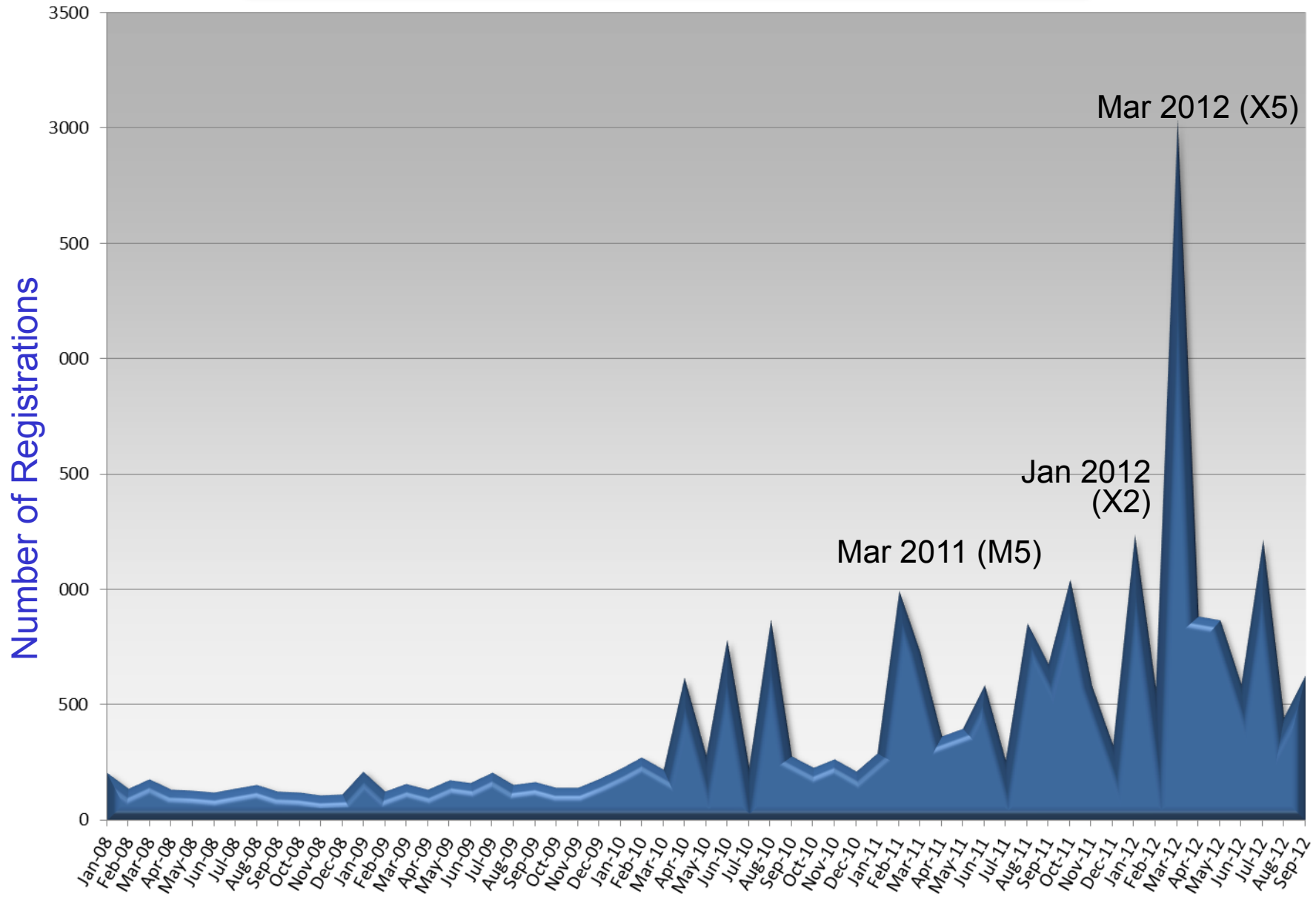
- **Customers & Service Trends**
- **Improving Operational Services for a Weather Ready Nation**
- **Interagency Activities**
- **International Collaborations**



# Customer Growth SWPC Product Subscription Service



# New SWPC Product Subscription Registrations by Month



- 
- Customers & Service Trends
  - **Improving Operational Services for a Weather Ready Nation**
  - Interagency activities
  - International collaborations

# NOAA's commitment to improved operations

## ■ Observations

- DSCOVR launch 2014
- GOES-R launch FY2016

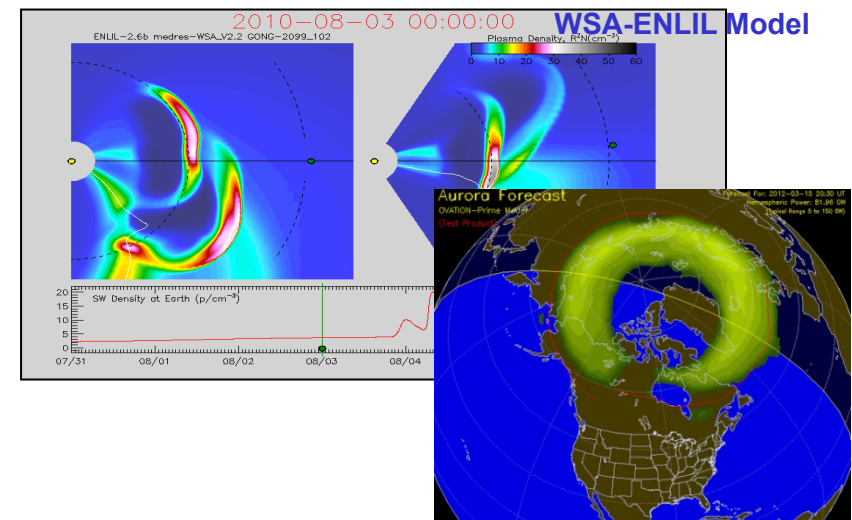


## ■ Model transition

- WSA-Enlil model
- Ovation – auroral forecast model

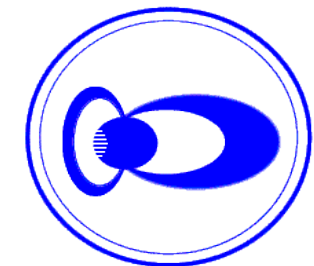
## ■ Space Weather Prediction Testbed

- Geospace Model
- The Whole Atmosphere Model



## ■ Upgrade operational product suite – critical new data sets

- Geomagnetic Storm Products
- USGS and INTERMAGNET data
- International Partners – magnetometer data



# NOAA Space Weather Scales

[http://www.swpc.noaa.gov/NOAA\\_scales/](http://www.swpc.noaa.gov/NOAA_scales/)

Category		Effect	Physical measure	Average Freq. (1 cycle = 11 yrs)
Scale	Descriptor	Duration of event will influence severity of effects		

Radio Blackouts		
Scale	Descriptor	Effect
R 5	Extreme	<b>HF Radio:</b> Complete HF (high frequency**) radio blackout on the sunlit side of the Earth lasting for a number of hours. This results in radio contact with mariners and en route aviators in this sector. <b>Navigation:</b> Low-frequency navigation signals used by maritime aviation systems experience outages on the sunlit side of the Earth for one to two hours. Increased satellite navigation positioning for several hours on the sunlit side of Earth, which is not possible on the sunlit side of Earth.
R 4	Severe	<b>HF Radio:</b> HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. <b>Navigation:</b> Outages of low-frequency navigation signals cause error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.
R 3	Strong	<b>HF Radio:</b> Wide area blackout of HF radio communication, loss of contact for about an hour on sunlit side of Earth. <b>Navigation:</b> Low-frequency navigation signals degraded for about an hour.
R 2	Moderate	<b>HF Radio:</b> Limited blackout of HF radio communication on sunlit side of Earth for tens of minutes. <b>Navigation:</b> Degradation of low-frequency navigation signals for tens of minutes.
R 1	Minor	<b>HF Radio:</b> Weak or minor degradation of HF radio communication on sunlit side, occasional loss of radio contact. <b>Navigation:</b> Low-frequency navigation signals degraded for about an hour.

\* Flux, measured in the 0.1-0.8 nm range, in  $W m^{-2}$ . Based on this measure, not considered.  
\*\* Other frequencies may also be affected by these conditions.

## Radio Blackouts

Solar Radiation Storms		
Scale	Descriptor	Effect
S 5	Extreme	<b>Biological:</b> unavoidable high radiation hazard to astronauts on EVA; radiation exposure to passengers and crew in commercial jets at high latitudes (approximately 100 chest x-rays possible through the polar regions, and position errors make navigation extremely difficult). <b>Satellite operations:</b> satellites may be rendered useless, memory cause loss of control, may cause serious noise in image data, star trackers may be unable to locate sources; permanent damage to solar panels possible through the polar regions, and position errors make navigation extremely difficult. <b>Other systems:</b> complete blackout of HF (high frequency) communication possible through the polar regions, and position errors make navigation extremely difficult.
S 4	Severe	<b>Biological:</b> unavoidable radiation hazard to astronauts on EVA; radiation exposure to passengers and crew in commercial jets at high latitudes (approximately 10 chest x-rays) is possible. <b>Satellite operations:</b> may experience memory device problems and imaging systems; star-tracker problems may cause orientation problems; solar panel efficiency can be degraded. <b>Other systems:</b> blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.
S 3	Strong	<b>Biological:</b> radiation hazard avoidance recommended for astronauts; passengers and crew in commercial jets at high latitudes may receive radiation exposure (approximately 1 chest x-ray). <b>Satellite operations:</b> single-event upsets, noise in imaging system, reduction of efficiency in solar panel are likely. <b>Other systems:</b> degraded HF radio propagation through the polar regions and increased navigation errors likely.
S 2	Moderate	<b>Biological:</b> none. <b>Satellite operations:</b> infrequent single-event upsets possible. <b>Other systems:</b> small effects on HF propagation through the polar regions and increased navigation errors possible.
S 1	Minor	<b>Biological:</b> none. <b>Satellite operations:</b> none. <b>Other systems:</b> minor impacts on HF radio in the polar regions.

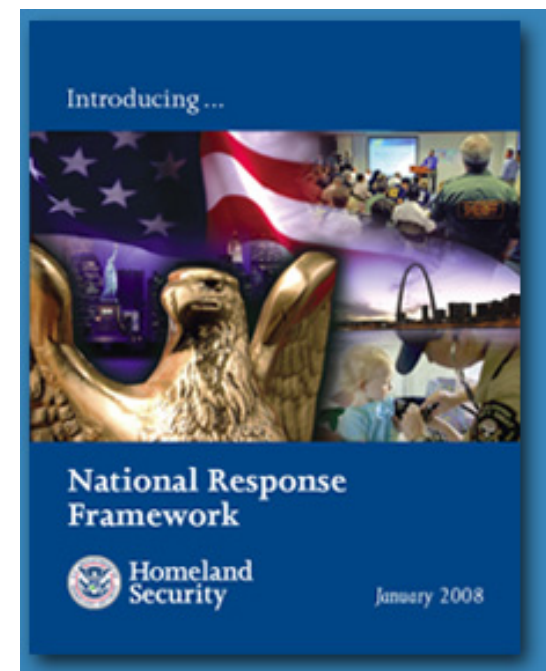
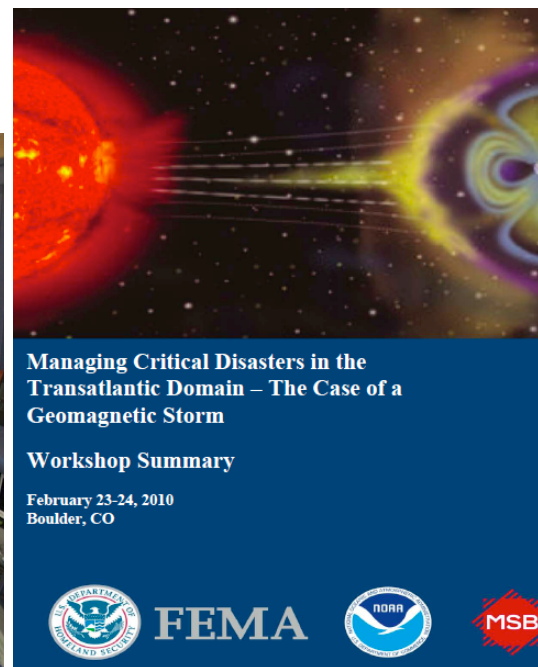
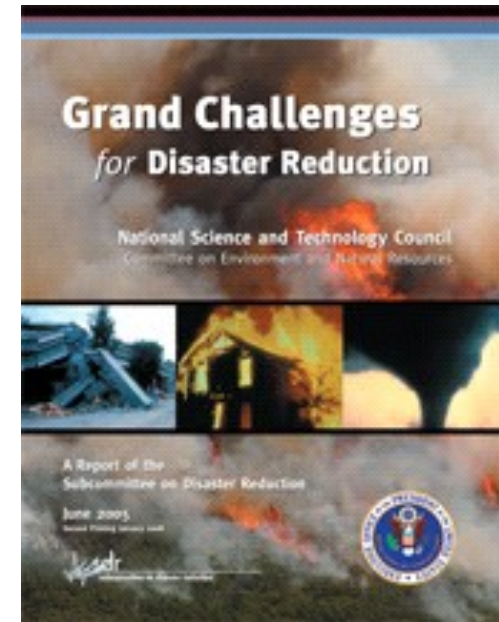
## Radiation Storms

Geomagnetic Storms		
Scale	Descriptor	Effect
G 5	Extreme	<b>Power systems:</b> widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. <b>Spacecraft operations:</b> may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. <b>Other systems:</b> pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.)**.
G 4	Severe	<b>Power systems:</b> possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. <b>Spacecraft operations:</b> may experience surface charging and tracking problems, corrections may be needed for orientation problems. <b>Other systems:</b> induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.)**.
G 3	Strong	<b>Power systems:</b> voltage corrections may be required, false alarms triggered on some protection devices. <b>Spacecraft operations:</b> surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. <b>Other systems:</b> intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.)**.
G 2	Moderate	<b>Power systems:</b> high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. <b>Spacecraft operations:</b> corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. <b>Other systems:</b> HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.)**.
G 1	Minor	<b>Power systems:</b> weak power grid fluctuations can occur. <b>Spacecraft operations:</b> minor impact on satellite operations possible. <b>Other systems:</b> migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine)**.

## Geomagnetic Storms

# Contributing to Federal Level Activities

- Space weather being addressed at all levels of government.
- Government working on ways forward to develop and implement mitigation strategies to safeguard critical infrastructure from the impacts of severe space weather.







# Homeland Security

Subscribe | Contact Us | Site Map

Home | Topics | How Do I? | Get Involved | News | About DHS

Home > About DHS > Organization > The Strategic National Risk Assessment (SNRA)

## The Strategic National Risk Assessment (SNRA)

The Strategic National Risk Assessment (SNRA) was executed by the DHS Office of Risk Management and Analysis in support of Presidential Policy Directive 8 (PPD-8), which calls for the creation of a National Preparedness Goal, a National Preparedness System, and a National Preparedness Report. Specifically, national preparedness is to be based on core capabilities that support "strengthening the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the Nation, including acts of terrorism, cyber attacks, pandemics, and catastrophic natural disasters."

As part of the effort to develop the National Preparedness Goal and identify core capabilities, the Secretary of Homeland Security led an effort to help identify the types of incidents that pose the security. The assessment was used:

- To identify high risk factors that supported development capability targets in the National Preparedness

**Homeland Security Office**  
NPPD Risk Management & Analysis  
More from DHS

- [The Strategic National Risk Assessment in Support of PPD 8 \(PDF, 7 pages - 144 KB\)](#)

**About DHS**

- [The Secretary](#)
- [Budget & Performance](#)
- [Careers](#)
- [Contact Us](#)
- [Do Business with DHS](#)
- [History](#)
- [Laws & Regulations](#)
- [Mission](#)
- Organization**
  - [Advisory Panels & Committees](#)
  - [Department](#)

# Strategic National Risk Assessment

Threat/Hazard Group	Threat/Hazard Type	National-level Event Description
Natural	Animal Disease Outbreak	An unintentional introduction of the foot-and-mouth disease virus into the domestic livestock population in a U.S. state
	Earthquake	An earthquake occurs within the U.S. resulting in direct economic losses greater than \$100 Million
	Flood	A flood occurs within the U.S. resulting in direct economic losses greater than \$100 Million
	Human Pandemic Outbreak	A severe outbreak of pandemic influenza with a 25% gross clinical attack rate spreads across the U.S. populace
	Hurricane	A tropical storm or hurricane impacts the U.S. resulting in direct economic losses of greater than \$100 Million
	Space Weather	The sun emits bursts of electromagnetic radiation and energetic particles causing utility outages and damage to infrastructure
	Tsunami	A tsunami with a wave of approximately 50 feet impacts the Pacific Coast of the U.S.
	Volcanic Eruption	A volcano in the Pacific Northwest erupts impacting the surrounding areas with lava flows and ash and areas east with smoke and ash
Wildfire	A wildfire occurs within the U.S. resulting in direct economic losses greater than \$100 Million	



# Space Weather Event Alert & Notification – Federal Emergency Management Agency (FEMA)

- Directly or indirectly cause or exacerbate a major disaster or emergency
- Interfere with or seriously degrade FEMA's response & recovery capability

## Notification / Action

**S4-S5 Radiation Storms**  
**G4-G5 Geomagnetic Storms**

FOC

Notify  
Leadership

FAOC-  
West

ENS to MOCs &  
Watches; Send Plain  
Language Email

NRCC-  
RWC

Notify NOC;  
Broad Distro Plain  
Language Email

FAOC-  
East

NAWAS / WAWAS  
(S5, G5 only)

*E-mail alert via  
Subscription Service*

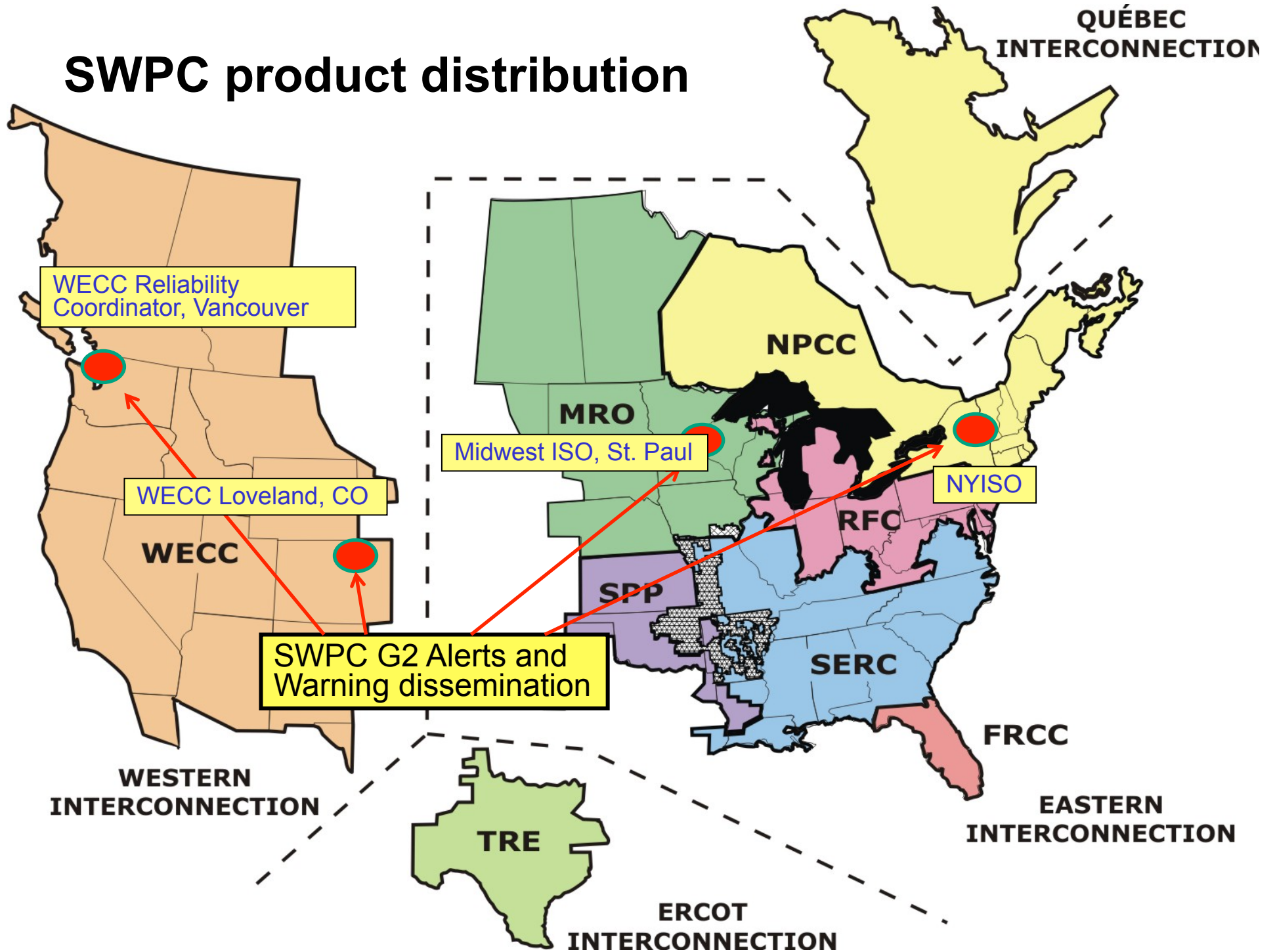
FEMA Operation  
Centers

*Situational  
Awareness*

**R2, S3, G3**



# SWPC product distribution



# Contributing operational support to national and state exercises on space weather

- **National & State Exercises**

- Table top exercises to discuss space weather and how to incorporate into planning documents


- **Emergency Planning**

- Integrating into plans and procedures
- Training
- Response and preparation documentation



National Oceanic and Atmospheric Administration Space Weather Prediction Center (NOAA)  
&  
New Jersey Office of Homeland Security & Preparedness (OHSP)  
*Presents*  
**Solar Weather Trends and Impacts on Critical Infrastructure**


**Date:** Thursday, March 1, 2012  
**Time:** 9:00 am – 12:00 pm  
**Location:** NJ Office of Homeland Security & Preparedness  
1200 Negron Drive Hamilton, NJ 08610



**2011 Virginia Emergency Response Team Exercise (VERTEX)**

Space Weather Workshop

•The overarching purpose of the 2011 (VERTEX) series is to develop and test a statewide strategy to respond to and manage the effects of Geomagnetically Induced Currents on the Commonwealth's electrical power and communications systems,




**Severe Space Weather Threats to the National Electric Grid**

*Briefings from Workshops and Exercises Preparing for Long-Term Grid Outages*

U.S. Capitol Visitor Center  
Congressional Auditorium & Atrium

6 October 2011



FloridaDisaster.org  
Florida Division of Emergency Management

Public | Business | EM Community | Organization

**Prepare and Stay Aware!** FL Hazard L

[Training / Events Home](#) > More Information

**Exercise Information page**


[Summary](#)  
[Point of Contact](#)  
[Participant List](#)  
[Standby List](#)  
[Apply for this Exercise](#)

<b>Name</b>	Energy Assurance State-wide Geomagnetic Storm Table Top Exercise
	This exercise will include presentations on geomagnetic storms, their potential effects, and how we predict and monitor them as well as a scenario to exercise our preparedness and response.

# Education & Outreach

- National Space Weather Portal
- NWS Training Center just released module for NWS Weather Forecast Offices
- WMO Space Weather Product Portal
  - WMO Training Modules developed via NWS Training Center (2013)
- Social Media – Visit SWPC on Facebook
- Overhaul of SWPC Web Page – in progress
- Training developed via COMET
  - SWx Basics Module
  - SWx Impacts on Aviation Module



- 
- Customers & Service Trends
  - Improving Operational Services for a Weather Ready Nation
  - **Interagency activities**
  - International collaborations

# Unified National Space Weather Capability

Federal agencies working together to develop a unified approach to understand and mitigate impacts of space weather on our Nation

- Improve use and integration of available space weather observations into operations
- Improve and accelerate research to operations
- Develop new and improved mission-tailored space weather products and services
- Improve collaboration between National Space Weather Program agencies
- Improve coordination & cooperation with international community



# National Space Weather Portal

[www.spaceweather.gov/portal](http://www.spaceweather.gov/portal)



**National Space Weather Program**  
Unified National Space Weather Portal

Welcome Products/Services Research Infrastructure Data Outreach Programs International Commercial

Reports

AGENCY PARTICIPANTS

Department of Commerce Department of Health and Human Services Department of Justice Department of Homeland Security Department of Energy Department of State Department of Transportation NASA NSF

## Welcome

The Unified National Space Weather Portal provides a gateway to access federally funded space weather information, services, and activities. It connects to a system of existing portals and websites, providing national information to enhance understanding.

This portal was developed through the National Space Weather Program (NSWP) as part of the Unified National Space Weather Capability. The NSWP is an interagency initiative to speed improvement in space weather services and prepare the country to deal with technological vulnerabilities associated with the space environment.



- Coordinated through the National Space Weather Program
- Provides a gateway to access federally funded space weather information, services, and activities
- Connects to a system of existing portals and websites, providing national information to enhance understanding



# Unified National Space Weather Portal

- Welcome
- Products/Services**
- Research
- Infrastructure
- Data
- Outreach
- Programs
- International
- Commercial
- Reports

## AGENCY PARTICIPANTS



**National Weather Service**  
**Space Weather Prediction Center**

Site Map News

https://afweather.afwa.af.mil/weather/spaceweather.html



## SPACE WEATHER

### Products and Services

There are several organizations providing space weather products and services. Prediction Centers have the mission to be the official source and Air Force is the military source. Specialized products for various audiences.

### Authoritative Space Weather

- [NOAA Space Weather Prediction Center](#)
- [DoD - Air Force Weather Agency](#)

### Specialized Space Weather Services

- [NASA Space Weather Laboratory](#)
- [USGS geomagnetism real time data](#)
- [Air Force Research Laboratory](#)
- [NASA Integrated Space Weather Analysis System](#)

### International

- [World Meteorological Organization \(WMO\) products](#)

#### Why Space Weather Matters

Headquarters U.S. Air Force  
*Aim High... Fly, Fight, Win*

**Space Weather Workshop 2012**  
 Air Force Weather Activities



Col John Egentowich, PhD.  
 AF Deputy Director of Weather  
 AF/A30-W  
 25 April 2012

**U.S. AIR FORCE**

This Briefing is Approved for Public Release

#### Contacts

55th Wing Public Affairs  
 109 Washington Square, Suite 221  
 Offutt Air Force Base, NE  
 68113

-----

Com'l: (402) 294-3663  
 DSN: 271-3663  
 E-Mail: [afwapa@offutt.af.mil](mailto:afwapa@offutt.af.mil)

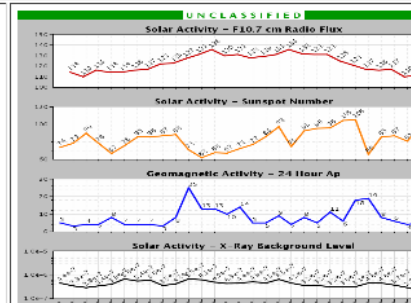
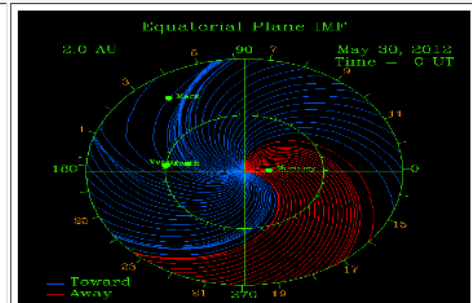
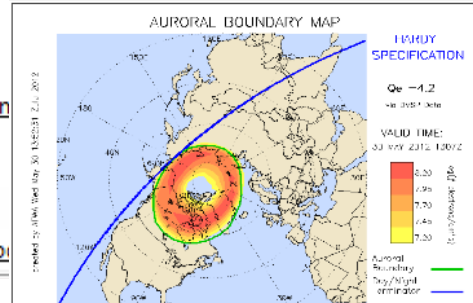
#### Space Weather Training

Run As Slide Show Once Opened



Approved for Public Release April 2012

### Current Products



AGENCY PARTICIPANTS



## Satellite and Ground Based Infrastructure

The U.S. government supports satellite and ground based infrastructure to aid in space weather research and operations

### Satellite

- ACE: Advanced Composition Explorer
- AMPERE: Active Magnetosphere and Planetary Electrodynamics Response Experiment
- COSMIC: Constellation Observing System for Meteorology, Ionosphere, and Climate
- DMSP: Defense Meteorological Satellite Program
- GOES: Geostationary Operational Environmental Satellites
- POES: Polar Operational Environmental Satellite
- SDO: Solar Dynamics Observatory
- SOHO: Solar and Heliospheric Observatory
- LASCO: SOHO Large Angle and Spectrometric Coronagraph Experiment
- STEREO: Solar Terrestrial Relations Observatory
- SECCHI: STEREO Sun Earth Connection Coronal and Heliospheric Investigation
- WIND



### Ground Based

- AMISR: Advanced Modular Incoherent Scatter Radar
- Arecibo Observatory
- GONG: Global Oscillation Network Group
- Millstone Hill Observatory
- Jicamarca Radio Observatory
- SEON: Solar Electro-Optical Network
- SuperDARN: Super Dual Auroral Radar Network
- USGS Magnetometer Network




- 
- Customers & Service Trends
  - Improving Operational Services for a Weather Ready Nation
  - Interagency activities
  - **International collaborations**

# Increased Global Interaction

*NOAA engaged in many international activities with many organizations*

World Meteorological Organization  
Working together in weather, climate and water

HOME CONTACT US LIST OF TOPICS LINKS CLIMATE STATISTICS

Space Weather Product Portal 

Programmes > Space > Space Weather > Product Catalogue

## Space Weather Product Portal

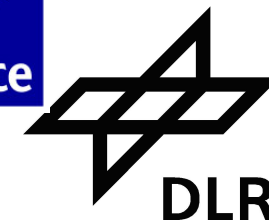
The Space Weather Product portal offers two ways of accessing products, either by product category or by providing organization. The *Search by Product Category* leads to selected product collections on local pages of the providing organizations with links to the products.

### Search by Product Category

Please select a domain and the product category to see what product collections are available from the different sources.

- △ Ionospheric
  - » HF communications
  - » Total Electron Content
  - » Ionospheric irregularities
- ▼ Geomagnetic
- ▼ Energetic Particles
- ▼ Solar and interplanetary

Ionospheric > HF communication	
Source	Product collection
IPS (Australia)	HF communications products
NICT (Japan)	HF communication products Japan
NOAA (USA)	HF communication products



Korea Radio Research Agency

# NOAA's Contribution to International Space Weather

*Global Threat – Global Response*

## Space Weather at the UN

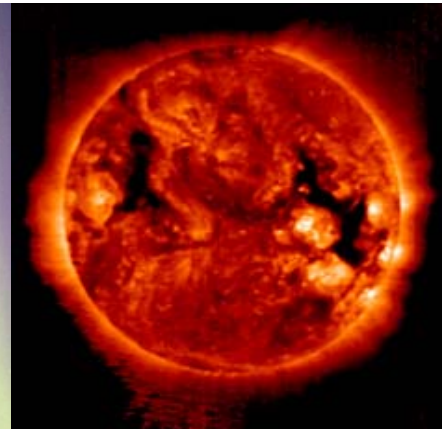
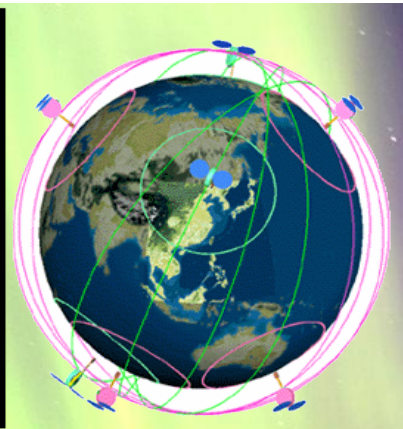
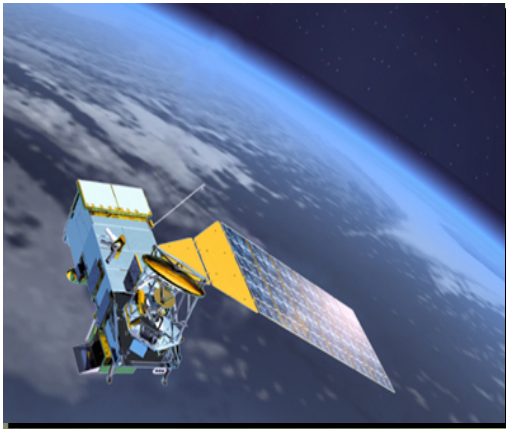
- World Meteorological Organization
- International Civil Aviation Organization
- UN Committee on the Peaceful Uses of Outer Space



## International Space Weather Operations

- United Kingdom
  - *Partnering on model development, forecaster training, and collaborative operational concepts, R2O*
- Korean Radio Research Agency
  - *Providing key real-time data from ACE*
- European Space Agency
  - *Plans to build upon respective capabilities*





## Global Impact – Global Challenge – Global Response

Provide the *right* information... in the *right* format...  
at the *right* time... to the *right* people...  
to make the *right* decisions!

